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PHYSICAL AND CHEMICAL OCEANOGRAPHIC DATA UMPQUA RIVER ESTUARY, OREGON. PART II: JANUARY 25-26, 1961

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Public Health Service
Portland, Oregon

February 1961

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PHYSICAL AND CHEMICAL OCEANOGRAPHIC DATA

UMPQUA RIVER ESTUARY

OREGON

Part II: January 25-26, 1961

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by
Richard J. Callaway
Oceanographer

UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service
Water Supply and Pollution Control Program
Region IX, Portland, Oregon
February, 1961

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ABSTRACT

Oceanographic data collected in the Umpqua River Estuary, Oregon, during the period January 25-26, 1961, are tabulated. Temperature, salinity, velocity, and oxygen were observed at various depths over one tidal cycle at one station. Temperature and salinity observations were made from the ocean to 11.5 miles upstream upon completion of the 25-hour station. A brief discussion of results is presented.

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INTRODUCTION

As part of the U. S. Public Health Service program of water supply and pollution control investigations in the Pacific Northwest, monthly surveys of oceanographical conditions in the Umpqua River Estuary, Oregon, are being carried out. The objectives of this oceanographical program have been described by Callaway (1960). A report has been issued listing data collected on a field trip during December 14-15, 1960 (Callaway, 1961).

This report contains data collected during January 25-26, 1961. A brief discussion of results obtained is presented.

STATIONS

The stations occupied are shown in Fig. 1. The station at Buoy 7 was occupied over one tidal cycle. Stations from the Coast Guard dock to Light 8 were occupied at approximately ten-minute intervals in an attempt to sample the estuary at the same tidal stage (higher high water).

DATA COLLECTED

Temperature and salinity data were obtained from the surface to the bottom at five-foot intervals. At the slack water stations samples were obtained when arriving on station. At Buoy 7 (25-hour station) samples were obtained every hour.

Velocity was measured every half hour at Buoy 7 at about five-foot intervals of depth.

Dissolved oxygen samples were collected at Buoy 7 every hour. Sampling depth was at five feet from the surface and one foot from the bottom.

The methods used and limits of accuracy are given below.

Temperature: Temperature data were obtained using a Chesapeake Bay Institute conductivity-temperature indicator (Schiemer and Pritchard, 1957) on loan from the Oregon Fish Commission. The accuracy of these data should be about $\pm 0.1^{\circ}C$.

Salinity: Salinity data were obtained using the CBI conductivity-temperature indicator. The accuracy of these data should be about $\pm 0.1^{\circ}/oo$.

Dissolved Oxygen: The Alsterberg modification of the Winkler determination for dissolved oxygen was used. The accuracy of these data should be about ± 0.1 ppm. Analyses were performed by Mr. Glenn Carter, Oregon State Sanitary Authority, Portland, Oregon, one to two days after collection of samples.

Velocity: The modified Jacobsen current drag described by Pritchard and Burt (1951) was used to determine velocity. These data should be accurate to ± 0.05 ft. per second. The upper limit of velocity measurements with the drag is about three knots.

DISCUSSION OF RESULTS

The brief discussion below serves to point out some of the more interesting features shown in the figures. It is not intended to be detailed.

Time Series

Fig. 2 shows a plot of observed velocity versus time at Buoy 7 and the predicted velocity curve obtained from the Tidal Current Tables (U. S. Department of Commerce, 1961). It is seen that while the agreement of times of slack and maximum currents is good, the agreement of the magnitude of velocity of predicted and observed tides is poor.

It was noticed that a strong east wind (up to 30 knots) coincided with the ebb current, which would increase the ebb.

The effect of runoff on the currents is shown by the difference in time of ebb and flood duration at the surface and twenty feet. At twenty feet flood current begins from one to two hours before flood at the surface, and the flood is stronger at depth. The duration and magnitude, however, of the ebb current at the surface is greater than at twenty feet.

Fig. 3 shows the predicted tidal curve for the entrance to the estuary (U. S. Department of Commerce, 1961). Comparison with Fig. 1 reveals that the strength of ebb and flood current occurs before the times of maximum high and low waters.

Further upstream where tidal vertical movement is damped there will still be periodicities in the current but these periodicities will consist of increasing and decreasing speed seaward, not upstream. This point is mentioned because there sometimes exists in the literature confusion between vertical movement of tidally influenced waters and the horizontal direction of flow.

Fig. 4 shows a time-series graph of dissolved oxygen distribution at five feet and at one foot from the bottom at Buoy 7. The significance of the low D.O. values at 2330 is not clear. Since this low D.O. value was observed only once and since the sample was taken near maximum ebb current, it is not related to upwelling and intrusion of oxygen deficient ocean waters.

The higher values of oxygen near the surface are related to the "age" of the containing water; that is, mixing continually aerates the surface waters, holding them relatively oxygen rich. The periodicity shown by the two curves is inverse to that shown by the salinity curves (Fig. 5). High salinity waters (greater percentage of ocean water) are associated with low (relatively) oxygen water and conversely.

The velocity curves of Fig. 2 are reproduced with Fig. 5 for convenience. Fig. 5 shows that while the salinity at twenty feet drops rapidly with the first ebb current cycle, it remains relatively constant after the first maximum flood current (at 1830). High salinity water ($\sim 31^{o}/oo$) brought upstream with the

flood is of such volume that the ebb current velocity and duration is not of sufficient magnitude to replace it with fresher water. With the succeeding stronger ebb cycle a marked decrease in salinity of the lower water would occur as shown from 0900-1700.

The above remarks concerning salinity can also be derived from the equation for salt continuity.

Vertical Profiles

Fig. 6 shows the vertical salinity profile from about 1.5 miles from the ocean to 11.5 miles upstream. The first 4 miles from the ocean show a well-mixed system (about $1^{o}/oo$ change in salinity with depth). From 5 to 9.5 miles upstream there is a marked stratification, the stratification decreasing beyond 9.5 miles.

It should be realized that there was a time lag of two hours between the two end stations and for this reason Fig. 6 does not represent a synoptic view at higher high water slack. A glance at Fig. 5 shows that had the station been occupied at 1400-1600 or 0100-0400, a well-defined salt wedge profile would have resulted.

Burt and McAlister (1959) reported that the limit of salt water penetration on January 26, 1956 at low water was only 3 miles upstream from the ocean. January 1956 was, however, a

period of high runoff (monthly mean at Elkton: 34.900 cfs; 25 year mean: 12,000 cfs from U. S. Geological Survey, 1959).

Since a conservative concentration such as salt was able to penetrate some 13 miles upstream (Fig. 6) it follows that this limit would be obtained by any conservative pollutant introduced into the waters.

Fig. 7 shows the vertical distribution of density expressed as sigma - t = 10^3 (specific gravity - 1). Comparison of Figs. 6 and 7 shows that both the lines of equal density and salinity have about the same slope. This merely points out that the structure of the estuarine waters is much more greatly influenced by the salt balance than by the temperature distribution, since the temperature distribution was nearly isothermal at all stations (see tabulated data). The density distribution profile also indicates the vertical stability of the water, since stability is proportional to the rate of change of sigma-t with depth.

Runoff

Table 1 shows computed values of mean current at five-foot intervals. The velocity-time series were planimetered to yield mean velocities according to the relation:

$$\bar{V} = \frac{1}{t - t_o} \int_{t_o}^{t} v \, dt$$

The interval $t - t_o$ is the duration in hours of each ebb or flood cycle (flood velocities were taken as negative).

The resultant mean velocity was plotted at depth and net ebb and flood velocities (V_n) planimetered according to the relation:

$$V_n = \frac{1}{Z - Z_o}\int_{Z_o}^{Z} \bar{V}\, dZ$$

The depth of zero relative motion was found to be 16.5 feet (Fig. 8). Runoff (R), or non-tidal drift, is then computed from the equation:

$$R = A_1\left[\frac{1}{Z-Z_o}\int_{Z_o}^{Z}\left\{\frac{1}{t-t_o}\int_{t_o}^{t} v\, dt\right\} dZ\right] - A_2\left[\frac{1}{Z_b-Z}\int_{Z}^{Z_b}\left\{\frac{1}{t-t_o}\int_{t_o}^{t} v\, dt\right\} dZ\right]$$

where, A_1 = cross-sectional area above depth of no motion

A_2 = cross-sectional area below depth of no motion

Z_o = surface

Z = depth of no motion

Z_b = bottom.

Since the anchor station was approximately in mid-channel, the average cross-channel velocities were taken as 2/3 the computed velocities. The runoff thus determined from equation 3 was found to be 2.2×10^4 ft^3 sec^{-1}.

The computed quantities are shown in Table 1.

As shown by Table 1 and Fig. 8 an effluent discharged in the upper 16.5 feet of water in the vicinity of Buoy 7 will be

carried seaward at about 0.30 knots if uniformly dispersed vertically. If discharged at the surface the net movement will be about 0.85 knots. An effluent discharged below 16.5 feet will have a net movement upstream.

There will be back diffusion of material in the upper layer to the limit of salt penetration, but the effect would be small.

PERSONNEL

In addition to the author, Messrs. Earl Kari and James Agee, U. S. Public Health Service, Portland, and Mr. Glenn Carter, Oregon State Sanitary Authority, Portland, participated in the field work.

ACKNOWLEDGMENTS

The loan of the Chesapeake Bay conductivity-temperature device was made possible through Mr. Dean Marriage of the Oregon Fish Commission. Thanks are also due Mr. Glenn Carter, Oregon State Sanitary Authority, for the oxygen analyses.

LITERATURE CITED

Callaway, Richard J.

1960. Prospectus for an oceanographical investigation of the Umpqua River Estuary and related studies on the Umpqua River Basin. Mimeographed report, U. S. Public Health Service, Portland, Oregon.

---- 1961. Physical and chemical oceanographic data, Umpqua River Estuary, Oregon. Part I: December 14-15, 1960. Mimeographed report, U. S. Public Health Service, Portland, Oregon.

Pritchard, D. W., and Burt, Wayne V.

1951. An inexpensive and rapid technique for obtaining current profiles in estuarine waters. Journal of Marine Research 10, 2, pp. 180-189.

Schiemer, W., and Pritchard, D. W.

1957. The Chesapeake Bay Institute conductivity-temperature indicator (CBI-CTI). The Johns Hopkins University, Chesapeake Bay Institute, Tech. Dept. XII, Ref. No. 57-1. (Unpublished manuscript).

U. S. Geological Survey.

1959. Surface water supply of the United States 1956. Part 14. Pacific slope basins in Oregon and Lower Columbia River Basin. Geological Survey Water Supply Paper 1448.

U. S. Department of Commerce Coast and Geodetic Survey.

1961. Tidal current tables 1961. Pacific Coast of North America and Asia.

---- 1961. Tide tables 1961. West coast of North and South America including the Hawaiian Islands.

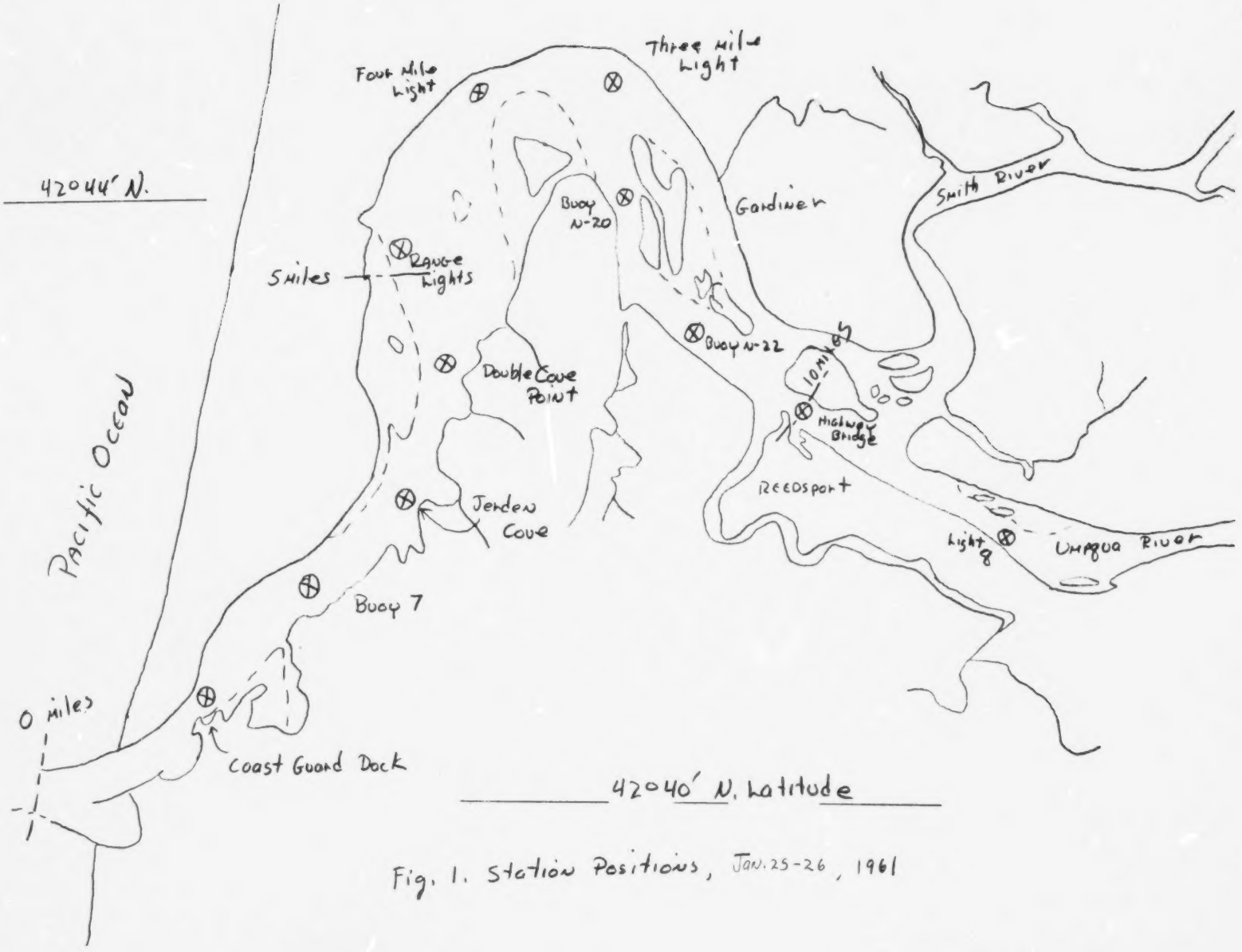


Fig. 1. Station Positions, Jan. 25-26, 1961

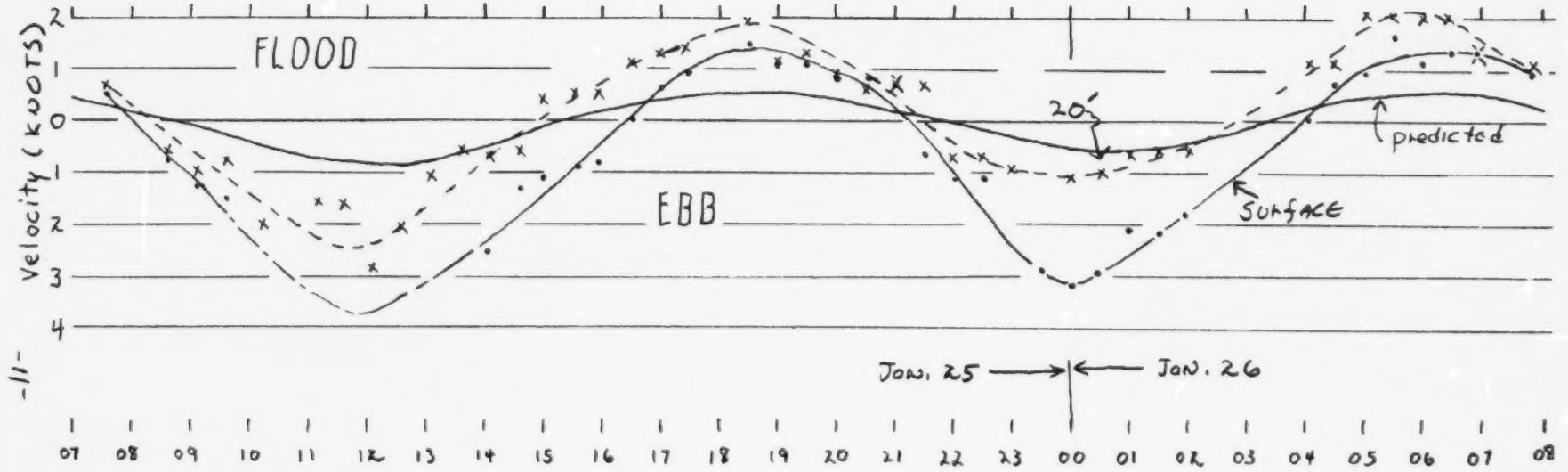


FIG. 2. Observed velocity, surface and twenty feet.
January 25-26, 1961. Umpqua River Estuary. Buoy 1.
(Smoothed by eye)
Predicted velocity is for River Entrance.

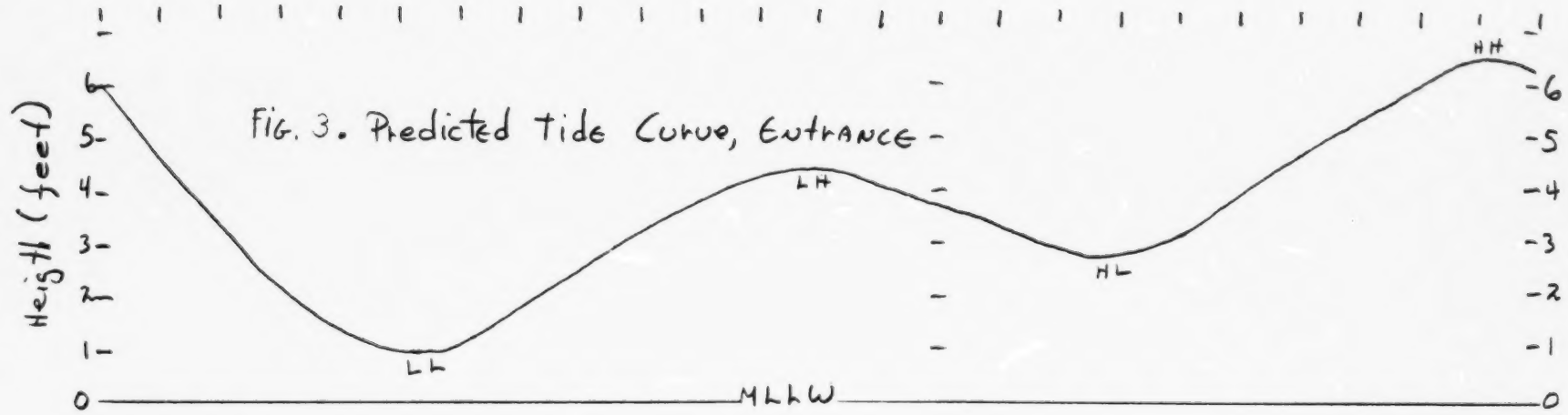


Fig. 3. Predicted Tide Curve, Entrance

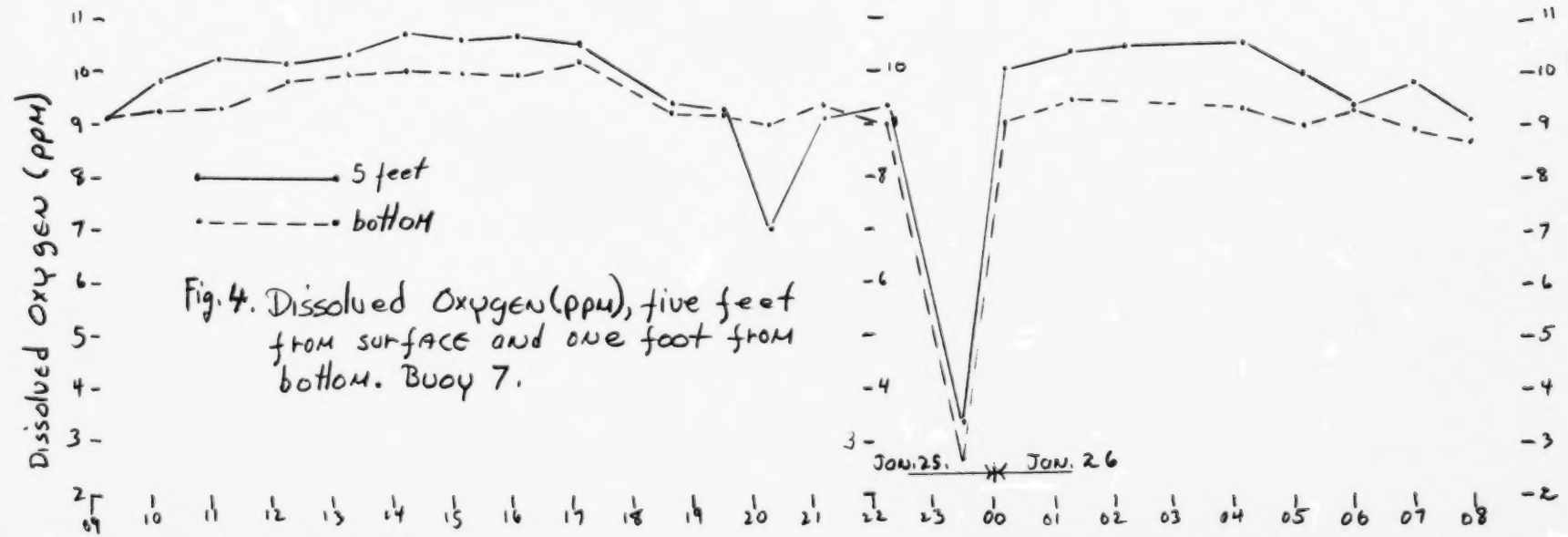
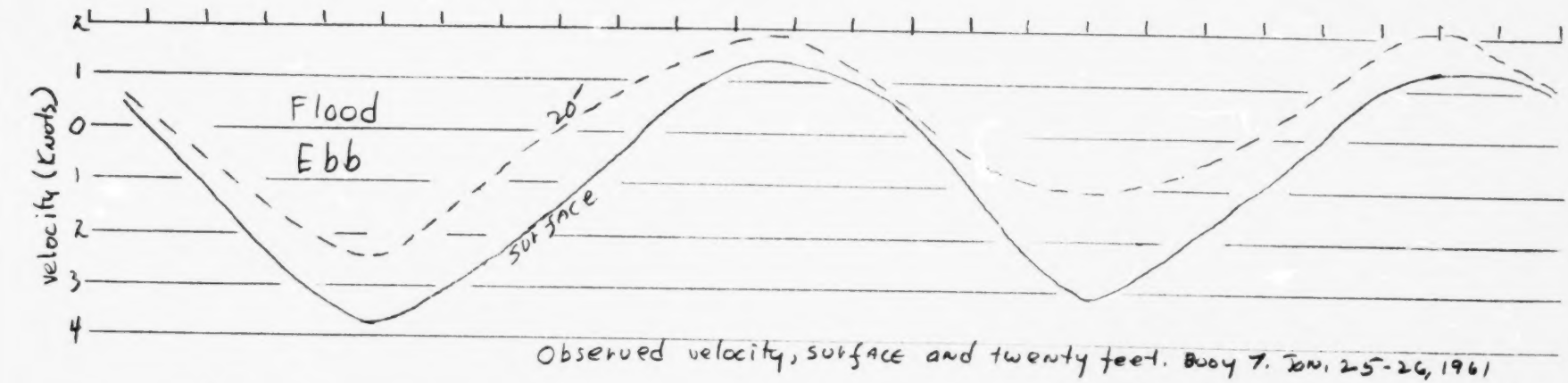


Fig. 4. Dissolved Oxygen (ppm), five feet from surface and one foot from bottom. Buoy 7.



Observed velocity, surface and twenty feet. Buoy 7. Jan. 25-26, 1961

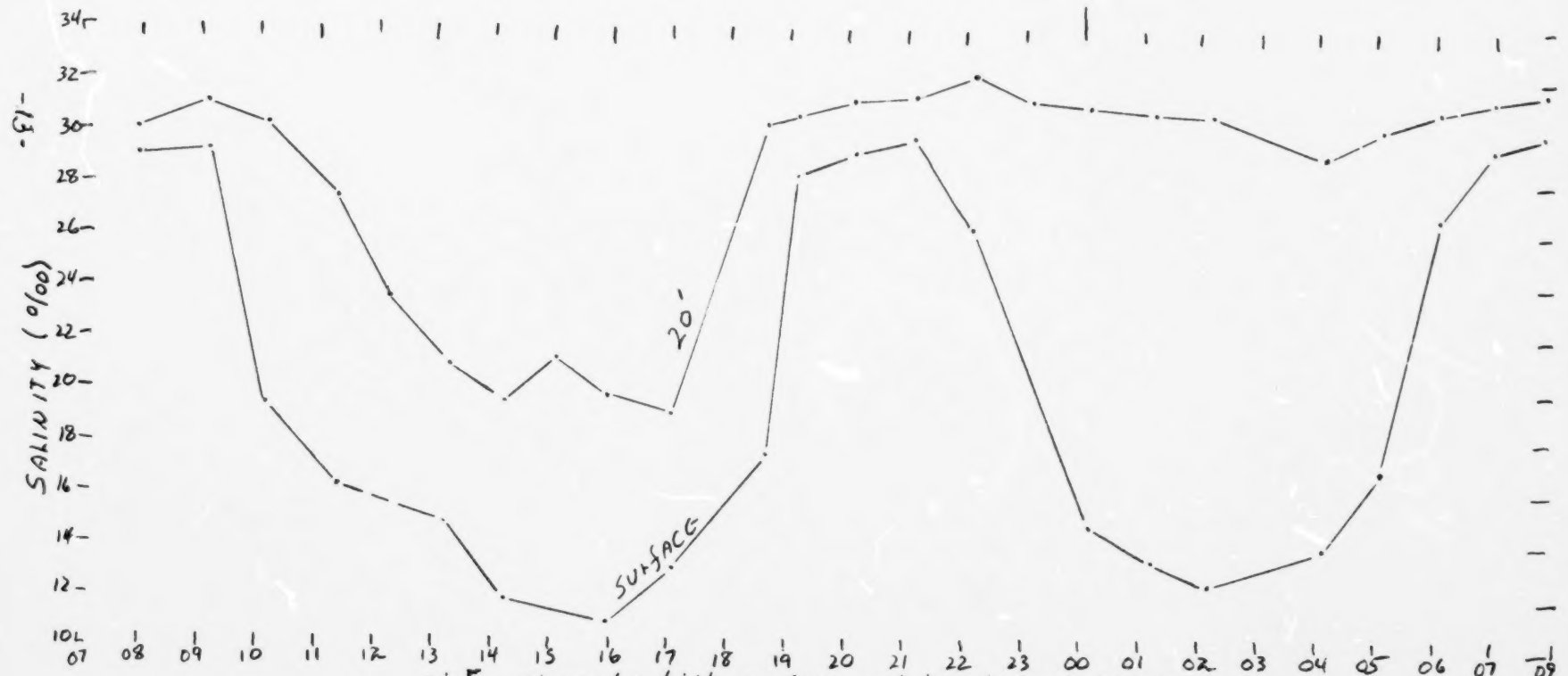


Fig 5. Observed salinity, surface and twenty feet. Buoy 7. Jan 25-26, 1961

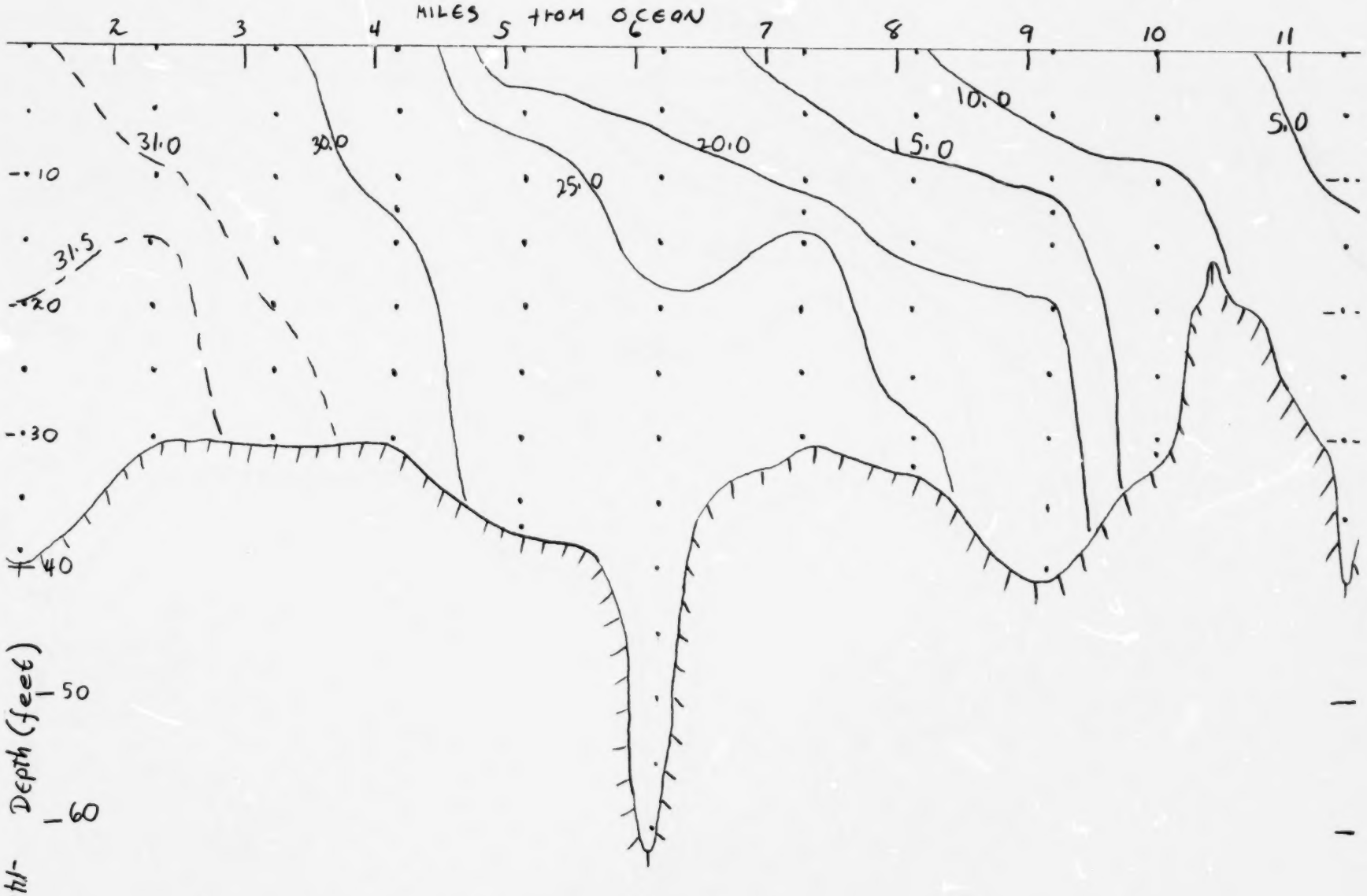


FIG. 6. Vertical profile of salinity, Umpqua River. Jan. 26, 1961
POINTS INDICATE OBSERVED VALUES.

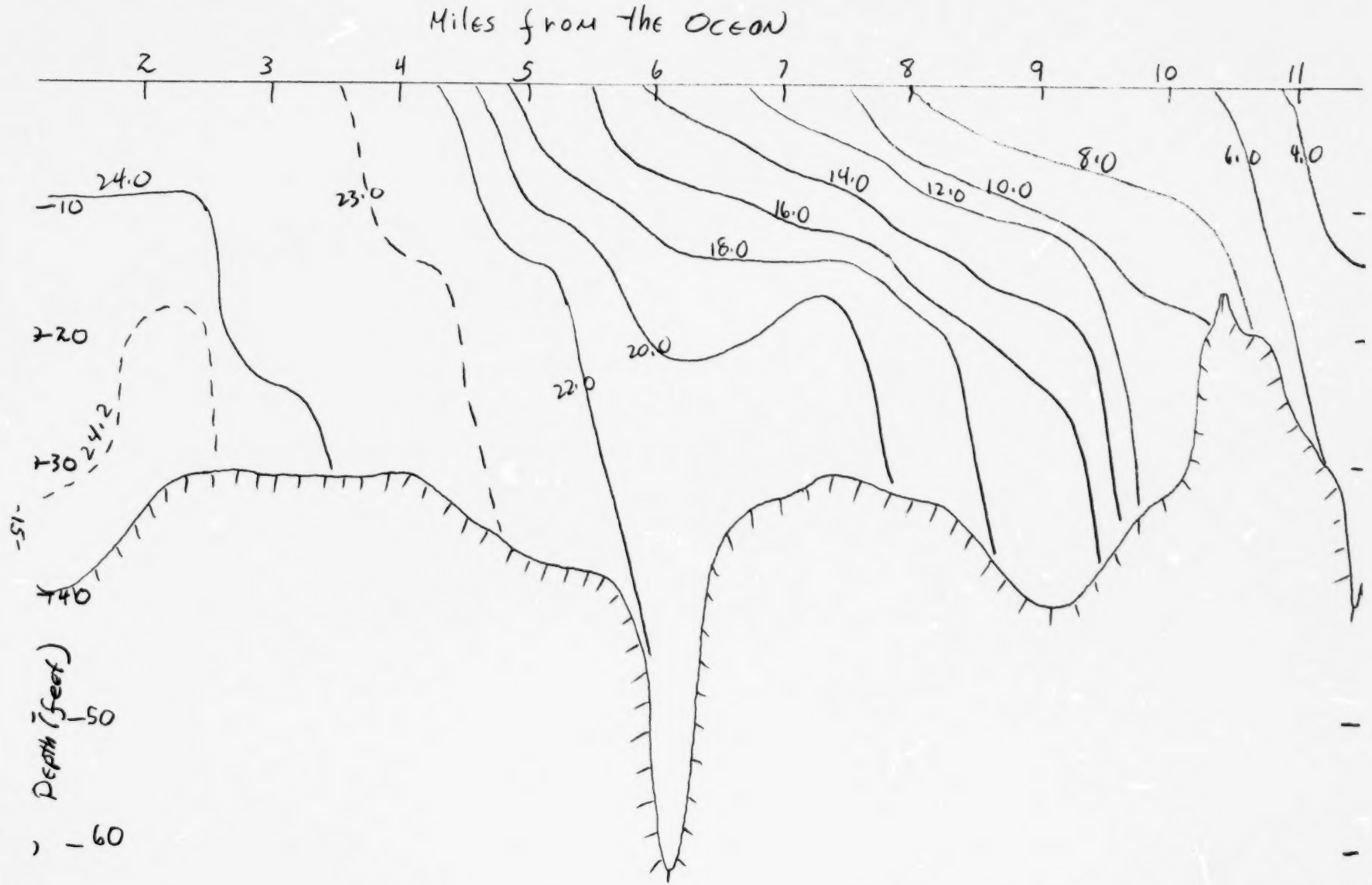


Fig. 7. Vertical profile of density (σ_t) Umpqua River. Jan. 26, 1961.

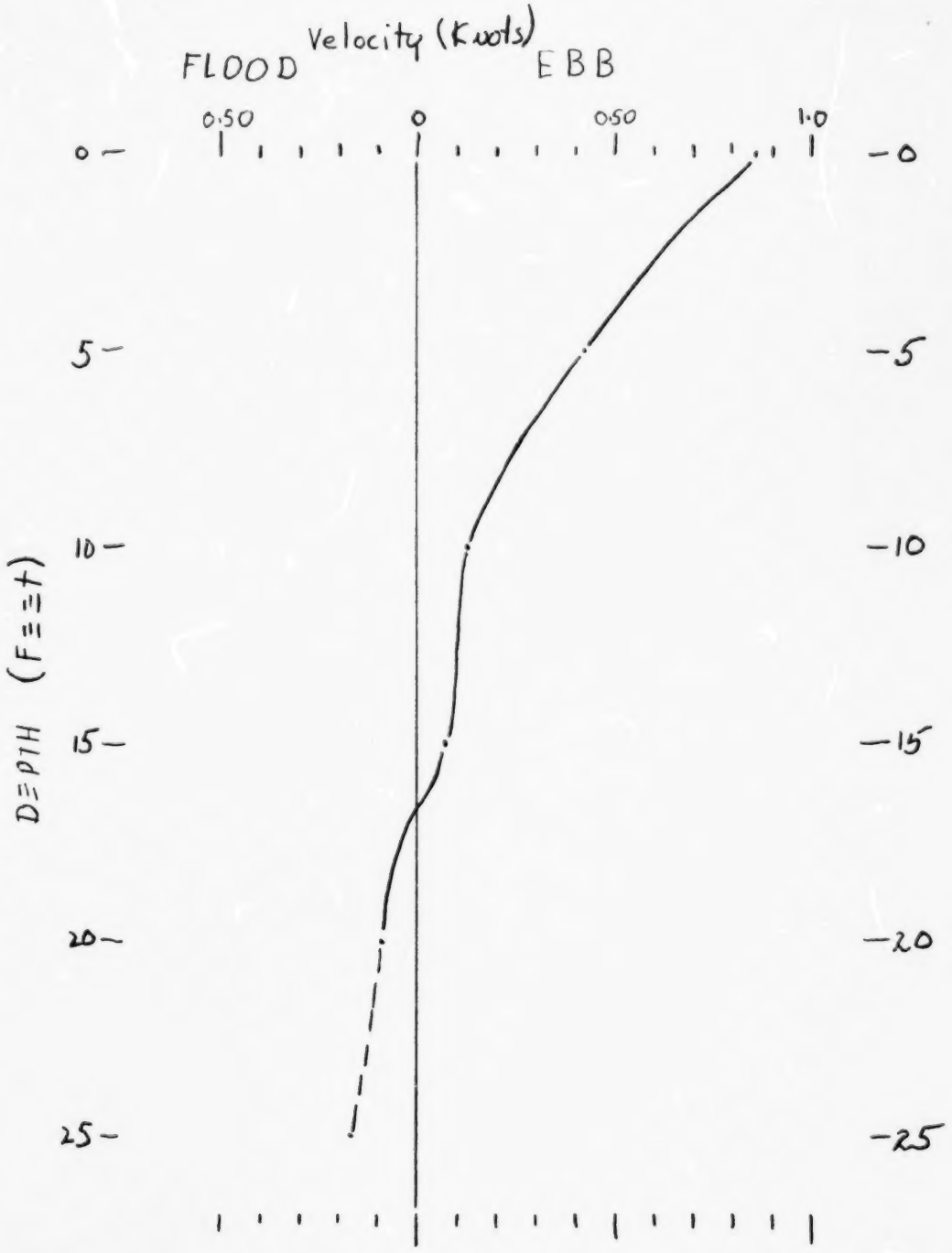


FIG. 8. Net Velocity. Buoy 7, Umpqua Estuary. Jan. 25-26, 1961.

TABLE 1
Computed Velocities, Buoy 7, Jan. 25, 26, 1961

Depth (feet)	Mean.Vel. (knots) / Duration (hours)	1st Ebb	1st Flood	2nd Ebb	2nd Flood
0	Mean. Vel.	2.20	0.95	1.76	0.96
	Duration	8.5	4.8	6.7	5.0
5	Mean. Vel.	2.20	1.10	1.27	1.35
	Duration	8.0	5.8	5.0	5.6
10	Mean. Vel.	2.01	1.14	0.86	1.54
	Duration	7.3	6.2	5.2	5.6
15	Mean. Vel.	1.82	1.06	0.71	1.38
	Duration	6.5	7.0	5.1	7.0
20	Mean. Vel.	1.34	1.05	0.78	1.18
	Duration	6.3	7.0	5.3	6.2
25*	Mean. Vel.	1.1	0.9	0.7	1.0
	Duration	6.3	7.2	4.3	6.9

*Includes extrapolated data.

Cross channel area, Buoy 7, mean lower low water: 87.8×10^3 ft^2
Mean tide level: Entrance, 3.7 ft.
Mean cross channel area: 107.6×10^3 ft^2
Mean area above depth of no motion: 76.3×10^3 ft^2
Mean area below depth of no motion: 31.3×10^3 ft^2
Net vel. above depth of no motion: 0.30 knots (seaward)
Net vel. below depth of no motion: 0.09 knots (upstream)

STATION: Buoy 7 DATE: January 25, 1961

TIME:	0757		0737		0837	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.5	30.0	0	0.5 F	0	0.8 E*
5	10.6	30.6	5	0.7	4	1.2
10	10.6	30.8	10	0.6	10	0.8
15	10.6	30.9	15	0.6	15	0.7
20	10.6	31.0	20	0.7	20	0.6
25	10.6	31.1	24	0.6	25	0.6
27	10.6	31.1	25	0.6	27	0.5

* E and F refer to ebbing and flooding current, not tide.

STATION: Buoy 7 DATE: January 25, 1961

TIME:	0912		0907		0937	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.1	29.2	0	1.3 E	0	1.5 E
5	10.4	30.5	5	1.0	5	1.2
10	10.5	30.6	8	1.3	8	1.2
15	10.5	30.9	12	1.2	14	1.0
20	10.6	31.0	17	1.1	19	0.8
25	10.6	31.1	22	1.0	24	0.8
28	10.6	31.1	27	1.0	28	0.5

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1007		1017			
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.6	19.4	0	3 + E		
5	9.2	23.8	5	3 +		
8	9.4	25.4	10	3 +		
14	10.2	29.6	15	2.0		
19	10.4	30.3	19	2.0		
24	10.4	30.5	28	1.6		
29	10.4	30.6	32	1.7		

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1122		1110		1137	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.8	16.3	0	3 + E	0	3 + E
5	8.5	18.0	5	3 +	5	3 +
9	8.9	20.6	10	3 +	10	3 +
13	9.5	24.4	15	3 +	15	3 +
18	9.8	26.9	17	1.7	17	1.7
23	10.0	27.9	24	1.4	23	1.4
24	10.1	28.9	25	1.4	26	1.3

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1212		1207		1237	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.3	----	0	3 + E	0	3 + E
4	8.6	16.3	5	3 +	5	3 +
9	8.8	19.5	10	3 +	10	3 +
13	9.2	21.0	15	3 +	15	3 +
17	9.3	23.2	22	2.2	19	2.2
22	9.4	24.1				
24	9.5	24.8				

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1312		1307		1337	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.5	14.9	0	3 + E	0	3 + E
5	8.6	16.8	4	(3.2)	3	2.7
9	8.8	18.1	9	2.6	10	1.2
14	8.8	18.7	19	1.2	18	0.7
19	9.1	20.7				
24	9.2	22.0				

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1412		1407		1437	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.9	11.9	0	2.5 E	0	1.3 E
5	8.4	14.3	4	2.0	4	1.2
10	8.7	17.0	10	1.1	8	1.1
15	8.8	18.7	15	0.7	14	0.8
20	8.9	19.5	19	0.8	19	0.6
25	9.1	20.7	21	0.6		

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1504		1500		1533	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.1	11.4	0	1.1 E	0	0.9 E
5	8.3	13.8	5	1.0	5	0.6
10	8.5	15.2	9	0.9	10	0.0
12	8.7	17.1	15	0.3 F	15	0.5 F
15	8.9	18.9	20	0.4	20	0.5
20	9.2	21.3				

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1558		1555		1630	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.1	11.0	0	0.8 E	0	0.0
5	8.2	12.2	5	0.0	5	0.0
10	8.6	15.2	10	0.5 F	9	0.8 F
15	8.8	18.0	15	0.7	13	1.0
20	9.0	19.8	20	0.7	18	1.0

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1705		1700		1725	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.4	13.1	0	0.7 F	0	0.9 F
5	8.4	13.4	5	0.8	5	1.0
10	8.8	16.6	7	1.4	7	1.4
15	9.0	19.0	11	1.5	11	1.4
20	8.9	19.0	12	1.8	15	1.4
			20	1.3	19	1.4

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1840		1830			
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	9.3	17.5	0	1.5 F		
5	10.2	27.9	4	1.8		
10	10.4	29.8	6	2.5		
15	10.5	30.2	9	2.5		
20	10.5	30.3	15	2.0		
22	10.5	30.3	22	1.7		
			28	0.9		

STATION: Buoy 7 DATE: January 25, 1961

TIME:	1910		1900		1930	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.2	28.2	0	1.1 F	0	1.1 F
5	10.4	29.1	4	1.6	5	1.3
10	10.5	30.5	8	1.7	9	1.4
15	10.5	30.5	14	1.3	14	1.4
20	10.5	30.6	19	1.1	18	1.5
			24	1.1	22	1.1

STATION: Buoy 7 DATE: January 25, 1961

TIME:	2010		2000		2030	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.2	29.1	0	0.9 F	0	0.9 F
5	10.6	30.8	5	0.9	5	0.9
10	10.6	31.0	10	1.1	10	1.1
15	10.6	31.1	15	0.8	15	0.6
(20)	(10.6)	(31.2)	20	0.9	20	0.6
			23	0.6	24	0.6

STATION: Buoy 7 DATE: January 25, 1961

TIME:	2110		2100		2130	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.4	29.7	0	0.7 F	0	0.7 E
5	10.4	29.8	5	0.7	5	0.7 F
10	10.5	30.6	10	0.8	10	1.1
15	10.6	31.1	15	0.7	15	1.0
20	10.6	31.3	20	0.7	20	0.7
25	10.6	31.4	24	0.7	21	0.7

STATION: Buoy 7 DATE: January 25, 1961

TIME:	2210		2200		2230	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	9.6	26.2	0	1.1 E	0	1.1 E
5	10.4	31.2	5	0.0	5	1.3
10	10.6	32.1	10	0.7 E	10	0.8
15	10.6	32.2	15	0.7	15	0.7
20	10.6	32.2	20	0.7	20	0.7
23	10.6	32.3	25	0.0	23	0.5

STATION: Buoy 7 DATE: January 25, 1961

TIME:	2310		2300		2330	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	9.0	21.2	0	2.4 E	0	2.9 E
5	10.3	29.4	5	1.5	4	1.6
10	10.5	30.4	10	1.1	10	0.9
15	10.6	31.0	15	0.9	15	0.7
20	10.6	31.2	19	0.9	16	0.6

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0010		0000		0030	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.2	14.8	0	(3.2) E	0	2.9 E
5	9.6	24.3	4	1.7	4	1.6
10	10.4	29.8	10	0.9	9	1.7
15	10.6	30.8	15	0.8	14	1.3
20	10.6	31.0	19	1.1	19	1.0
22	10.6	31.1				

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0115		0100		0130	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.1	13.5	0	2.1 E	0	2.2 E
5	8.4	15.7	4	2.0	4	2.0
10	9.2	21.2	10	0.9	9	1.7
15	10.4	29.8	15	0.6	15	0.9
20	10.6	30.7	20	0.6	19	0.6
22	10.6	30.9				

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0210		0200			
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.9	12.5	0	1.8 E		
5	8.6	16.0	5	0.9		
10	9.8	25.9	10	0.6		
15	10.4	29.8	15	0.6		
19	10.6	30.6	19	0.6		

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0410		0405		0430	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.0	13.9	0	0.0	0	0.7 F
5	8.1	14.2	5	0.7 F	5	1.0
10	8.7	19.4	9	0.8	9	1.5
15	10.0	27.8	12	1.2	14	1.4
20	10.2	29.1	15	1.4	19	1.2
25	10.3	29.2	24	1.2	24	0.9

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0507		0500		0530	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.3	16.9	0	0.9 F	0	1.6 F
5	8.4	18.5?	5	1.3	4	2.1
10	9.3	24.9?	7	2.2	5	2.8
14	10.3	29.9	9	2.4	8	2.9
20	10.4	30.1	15	2.1	15	2.1
22	10.4	30.2	21	2.0	23	1.5
			22	1.7		

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0605		0600		0625	
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	9.5	26.7	0	1.1 F	0	1.3 F
5	10.1	29.4	4	1.8	3	2.7
10	10.4	30.5	6	2.3	6	2.6
14	10.4	30.7	10	2.8	8	2.7
19	10.4	30.8	12	2.0	18	2.1
24	10.4	30.8	20	2.0	24	1.8
			21	1.6		

STATION: Buoy 7 DATE: January 26, 1961

TIME:	0700		0655			
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.0	29.3	0	1.3 F		
5	10.5	30.9	4	1.9		
10	10.5	31.1	8	1.8		
15	10.5	31.2	13	1.7		
19	10.5	31.2	16	1.8		
25	10.5	31.3	23	1.1		

STATION: Buoy 7 DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 2.32

TIME:	0750		0755			
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.1	29.9	0	0.9 F		
5	10.2	30.1	5	1.1		
10	10.5	31.4	10	1.1		
15	10.5	31.5	14	1.4		
20	10.5	31.6	19	1.2		
25	10.5	31.6	24	1.1		
30	10.5	31.6	29	1.0		

STATION: Coast Guard Dock DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 1.34

TIME:	0740					
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.5	31.1				
5	10.4	31.1				
10	10.5	31.4				
15	10.5	31.4				
20	10.5	31.5				
25	10.5	31.5				
30	10.5	31.5				
35	10.5	31.6				
39	10.5	31.6				

STATION: Jerden Cove DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 3.25

TIME:	0815					
Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.3	30.6				
5	10.3	30.7				
10	10.4	30.8				
15	10.4	30.9				
20	10.4	31.0				
25	10.4	31.3				
30	10.5	31.4				

STATION: Double Cove Point DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 4.18

TIME: 0825

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	10.0	29.0				
5	10.0	29.3				
10	10.1	29.6				
12.5	10.2	29.8				
15	10.3	30.3				
20	10.4	30.6				
25	10.4	30.7				
30	10.4	30.7				

STATION: Range Lights DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 5.15

TIME: 0835

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.3	11.6				
5	9.0	23.2				
10	9.8	27.3				
15	10.1	28.7				
20	10.1	28.8				
25	10.2	29.0				
30	10.2	29.2				
35	10.2	29.5				
37	10.2	29.6				

STATION: Three-Mile Light DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 7.29

TIME: 0900

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.7	14.0				
5	8.1	15.9				
10	8.5	18.8				
12.5	9.4	23.2				
15	9.8	25.7				
20	9.9	26.8				
25	10.0	27.2				
30	10.0	27.2				

STATION: Buoy N-20 DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 8.13

TIME: 0910

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.1	10.1				
5	7.6	11.3				
10	8.1	15.6				
15	8.8	18.7				
20	9.5	23.9				
25	9.5	24.2				
30	9.7	25.5				
32	9.7	25.6				

STATION: Buoy N-22 DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 9.19

TIME: 0920

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.1	9.1				
5	7.1	9.1				
10	7.5	11.8				
12.5	8.4	15.9				
15	8.5	17.2				
20	8.9	20.3				
25	9.0	20.7				
30	9.0	20.8				
35	9.0	20.9				
40	9.0	21.0				

STATION: Highway Bridge DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 10.00

TIME: 0930

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	7.1	8.1				
5	7.1	8.1				
10	7.6	10.6				
15	7.9	12.7				
20	8.0	13.2				
25	8.0	13.5				
30	8.1	14.3				
31	8.2	14.6				

STATION: Light 8 DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 11.44

TIME: 0945

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	6.4	3.7				
5	6.4	3.8				
10	6.5	4.0				
15	7.1	6.2				
20	7.1	6.5				
25	7.2	6.9				
30	7.2	7.3				
36	7.2	7.5				

STATION: Four-Mile Light DATE: January 26, 1961

NAUTICAL MILES FROM OCEAN: 6.20

TIME: 0850

Depth (feet)	Temp. (°C)	Sal. (°/oo)	Depth (feet)	Vel. (knots)	Depth (feet)	Vel. (knots)
0	8.3	17.8				
5	8.6	19.7				
10	8.8	21.6				
15	9.1	24.1				
20	9.4	25.2				
25	9.9	27.2				
30	10.0	27.9				
35	10.0	28.2				
40	10.1	28.2				
45	10.0	28.3				
50	10.1	28.4				
55	10.1	28.5				
60	10.1	28.5				

TIME / DEPTH	0919	1007	1122	1222	1312	1412	1504	1602	1705	1840
5'	9.1	9.8	10.2	10.1	10.3	10.7	10.6	10.7	10.5	9.4
bottom	9.1	9.3	9.3	9.8	9.9	10.0	9.9	9.9	10.2	9.2

TIME / DEPTH	1930	2015	2110	2215	2315	0010	0120	0210	0410	0507
5'	9.3	9.0	9.1	9.4	3.4	9.1	10.4	10.5	10.6	10.0
bottom	9.2	7.0	9.4	9.0	2.7	10.3	9.5	----	9.3	9.0

TIME / DEPTH	0605	0700	0755
5'	9.3	9.2	9.1
bottom	9.4	8.9	8.7

TIME SERIES OF DISSOLVED OXYGEN, PPM, BUOY 7, UMPQUA RIVER
January 25-26, 1961